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BONE MARROW BIOPSY IN THE HORSE: A Study of the Normal Marrow Cytology in Cross-bred Ponies

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INTRODUCTION

In 1868, Neumann described the origin of erythrocytes in bone marrow, and in 1923 Seyfarth made the first biopsy by means of trephining the sternum. Arinkin (1929) introduced the needle puncture technique using a lumbar puncture needle, and the development of this technique for the examination of sternal marrow in man meant that, for the first time, bone marrow biopsy became a practicable proposition not only for the academic research worker, but also for the practising physician.

Biopsy material obtained by Arinkin's technique has been described and discussed by many authors, *e.g.*, Leitner (1949); Whitby & Britton (1953); Wintrobe (1951). The technique was modified by Salah, who, in 1934, introduced his special needle for biopsy specimens obtained by the method of Arinkin, and this needle remains to-day, in the view of many, the instrument of choice. It consists of a hypodermic needle and a trocar with an adjustable guard upon the shaft of the needle. The skin and subcutaneous muscle are penetrated and, when the bone is reached, the guard is set as far above the skin as penetration of the bone is desired. Only then is the needle inserted into the bone. Some workers do this by rotary movements, while others prefer the use of a hammer. Klima & Rosegger (1935) produced a needle with its guard on a thread, and Turkel & Bethel (1943) described an instrument for biopsy which consisted of a large bore hypodermic needle, which was to be passed through skin and muscle to the bone surface, and then through it a fine trephine was used to cut out a disc of bone and so to make marrow available for aspiration, or for the removal of sufficiently large fragments for sections to be made.

It is generally agreed by all workers that the total nucleated cell count of marrow biopsy specimens is so variable that it has little significance. Clearly, it will be affected to an unknown extent, both by dilution with blood, and by the extent to which marrow particles are included in the aspirated material. The blood dilution depends upon the size of the sample withdrawn.

Meyer & Bloom (1943) examined the bone marrow of dogs using the iliac crest, and Sawitsky & Meyer (1947) used the same site in cats. Rubinstein (1948) applied the iliac crest site to human marrow biopsy. Sawitsky & Meyer (1948) examined the bone marrow of guinea-pigs by aspiration from the iliac crest without anaesthesia. Epstein & Tomkins (1943) compared the results obtained from material by aspiration, by section of particles obtained by trephine biopsy and supra-vital techniques, and prefer section to smear. Isaacs (1928) showed that the aspiration technique can be repeated to give frequent serial examinations which are remarkably similar in a normal animal. Leitner (1949) prefers smear preparations stained with a panoptic stain for routine use. Propp (1951) uses marrow particle smears which he obtains by aspiration of 1 c.c. amounts of marrow fluid, neglecting the inevitable dilution with blood. If he is unable to find suitable particles when he ejects his aspirate into a watch glass he resorts to centrifugation and makes his smears from the "buffy coat" layer.

Erythropoiesis in man is reviewed by Dacie & White (1949) and they give an excellent description of the normal and abnormal erythroid cells. Osgood & Seaman (1944) and Leitner (1949) discuss the validity of the differential cell count on marrow biopsy specimens, and Osgood and Seaman further consider the statistical errors in differential counts and conclude that, for reasonable accuracy, at least 500 cells must be enumerated. They also compare section, imprint and smear preparations, and discuss their limitations. The normal cellular morphology of human bone marrow has been repeatedly described and excellent descriptions may be found, *e.g.*, Osgood & Ashworth (1937) "Atlas of Haematology"; Israels (1948) "Atlas of Bone Marrow Pathology"; Leitner (1949) "Bone Marrow Biopsy"; Wintrobe (1951) "Clinical Haemotology"; "The Sandoz Atlas of Haematology" (1952) (edited by Undritz & Rothlin); and Whitby & Britton (1953) "Disorders of the Blood."

BONE MARROW BIOPSY IN THE HORSE

References to bone marrow biopsy in the horse are, as yet, rare. In 1938 Hjarre & Berthelsen reported the use of sternal puncture biopsy in the horse for the diagnosis of equine infectious anaemia, but they quoted no figures for differential marrow counts. Hjarre (1943) quotes the following for normal differential figures for the horse:—

TABLE I

Myeloblast	Promyelocyte	Myelocyte	Metamyelocyte
Per cent. 1·5–3	Per cent. 1–2·5	Per cent. 2–6	Per cent. 5–15

Hjarre (1943)—Equine marrow cell differential count.

Tkachenko (1940) investigated the gross distribution of bone marrow in the horse at necropsy and quotes the following figures for his differential counts:—

TABLE II

Myeloblast	Promyelocyte	Myelocyte neutrophil	Eosinophils	Basophils
Per cent. 3–3·5	Per cent. 6–8	Per cent. 35–41	Per cent. 3·5–4	Per cent. 0·1–0·5

Tkachenko (1940)—Equine marrow cell differential count.

Calhoun (1946) performed marrow biopsy from the 11th to 16th rib in the horse and quotes the following figures from examination of seven horses.

Table III

Myeloblast	Promyelocyte	Myelocyte neutrophil	Eosinophils	Basophils
Not quoted	Per cent. 0–5	Per cent. 26–56	Per cent. 0·6–4·8	Per cent. 0–1·0

Calhoun (1946)—Equine marrow cell differential count.

None of the authors mention the type of horse nor the number of cells counted to arrive at their differential figures.

Code & Jensen (1941) mention that in one horse they examined the histamine content of the bone marrow was greater than that of peripheral blood, but they do not mention how they obtained this marrow. Sternal biopsy in horses is impracticable as a routine technique owing to the large cartilaginous keel which overlies the sternum together with massive musculature. Hjarre & Berthelsen (1938) overcame this difficulty by a lateral approach to the sternum. The ribs are easily accessible, but are extremely hard to penetrate; Calhoun (1946) used a twist drill to cut the bone. The risk of damage to the thoracic cavity, of fracture of the rib, and of damage to the operator himself preclude the satisfactory use of this site, other than under general anaesthesia. None of the sites and methods enumerated are satisfactory for routine use in the equine subject.

Of the other sites available the spine of the scapula is impracticable owing to its extreme mobility, and the processes of the vertebrae are so heavily overlaid with musculature that many difficulties are presented. Consideration was given to the use of bones of the leg (*e.g.*, the tibia), but the idea was abandoned because of the mobility of the part on the one hand, and because of its extreme exposure to infection after the operation, with potentially dangerous complications on the other hand.

The tuber coxae is almost invariably very close to the skin and is not of excessively hard bone. The marrow within it is plentiful in the young horse, indeed, up to yearling age, the marrow cavity fills almost the entire bone and biopsy is a simple matter. With increasing age the marrow cavity recedes and greater and greater depths have to be penetrated. Restraint is a simple matter when working upon this area of the body and resentment seems to be slight. Local anaesthesia is very satisfactory and this site has, so far, proved successful, although the biopsy is difficult in animals 10 years old or more. No untoward sequelae have been experienced, the animals walking sound immediately after the operation.

Methods Used in this Study

The animals used were a group of mongrel ponies crossed between one or more of the following breeds: Shetland, Exmoor, Welsh ponies and Shire. They were kept at pasture, all in one paddock, and brought in to the stables for a few days only, during which time the biopsies were performed. In each case the haematological picture, as seen by routine peripheral blood examination, was well known, the ponies having been bled once a fortnight for some months prior to these observations.

The site used was the tuber coxae, midway between its two tuberosities and somewhat towards its posterior border, and it is sufficiently large that at least three biopsies could be made on each side, say six in all, within a short space of time.

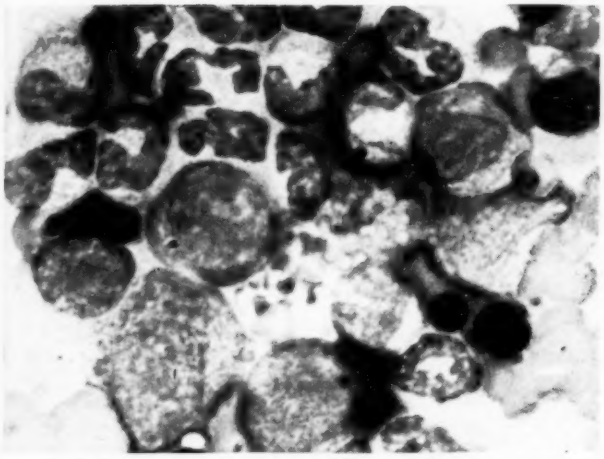
The animals were not prepared in any way except by shaving a generous area around the tuber coxae. A Salah needle was used, usually without its guard as this was hardly necessary, there being no danger of inadvertent penetration of the thoracic cavity, as would be the case if rib or sternal biopsy were to be performed. It has proved necessary to use a Salah needle with a 3½-inch shaft for the older animals so as to be able to reach the marrow cavity. The standard needles are suitable only for ponies less than five years old.

About 5 c.c. of 5 per cent. Planocaine (P.S. Ltd.) was injected subcutaneously from a point over the uppermost tuberosity in a downward direction so as to anaesthetise the chosen site for biopsy, but to leave its overlying skin intact. In these ponies the one injection of anaesthetic in one place gave excellent anaesthesia from skin to periosteum. The bone appears to be insensitive. The needle was introduced into the bone by steady rotary screwing motions and very little trouble has been experienced in achieving penetration. The needle was introduced in such a direction that it pointed at the hip joint of the opposite side. In foals only about ⅛-inch penetration was needed, but in mares 10 years old, or more, some 2 inches may be necessary and in these animals the direction for insertion of the needle is very critical. Suction was applied by means of a 20 c.c. syringe with a glass plunger, about ¼ c.c. only of marrow fluid being withdrawn. Quite considerable force was needed and the marrow sometimes took a few moments to spurt into the syringe even when the plunger was held fully withdrawn.

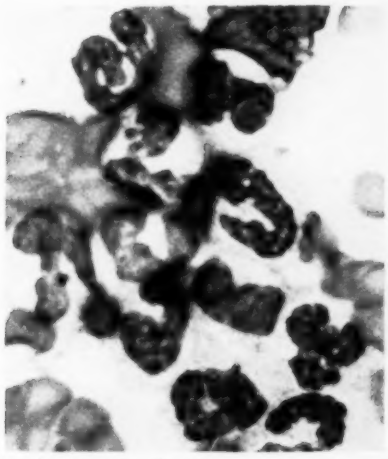
Smears were made immediately on grease free slides and approximately ¼ c.c. of the marrow was ejected into a bijou bottle containing evaporated remains from 0·6 c.c. of a 1 per cent. solution of the Na_2 salt of ethylene-diamine-tetra-acetic acid (Hadley & Larson (1953); Archer (1954)). After this process the Salah needle was removed and 300,000 units of procaine penicillin were injected subcutaneously at the biopsy site. The smears were air dried and were stained by Leishmann's stain (Hopkins & Williams—"Revector" brand) for one minute undiluted and for 20 minutes diluted in the usual way but with buffer *p*H 6·8 and not with distilled water. Further smears were stained with Sudan Black according to the method of Hayhoe (1953). Total nucleated cell counts were made on the material collected in the anticoagulant. Differential nucleated cell counts were made on the Leishmann stained smears, not less than 500 cells being enumerated in all from not less than two separate smears. The Sudan Black smears were used for detailed examination of the lipid distribution within the cells.

Discussion

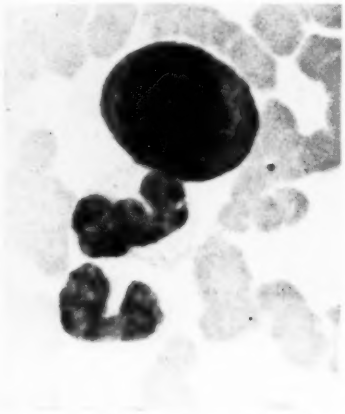
The results are indicated in Table IV. The weights of the various ponies are included, and their ages. The total cell counts would seem to bear out previous observations and are so variable that their value must be very slight. Israels (1948) suggests that a good idea of the cellularity of a marrow can be made from the smear although he performs a total cell count as routine. Morphologically, the striking feature in the horse is the size of the eosinophil granules. These are exceedingly large as compared with human eosinophil granules, while the basophil granules are smaller than those of the human counterpart cell. The eosinophil myelocytes contain much smaller granules than the adult forms, while the eosinophil promyelocyte granules are quite fine. Some of the granules may fail to take up



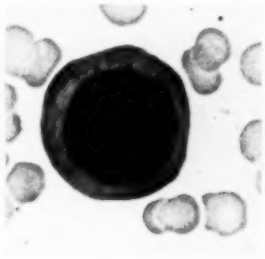
1. Typical marrow cell group showing myelocytes, metamyelocytes and polymorphs. × 1,300.



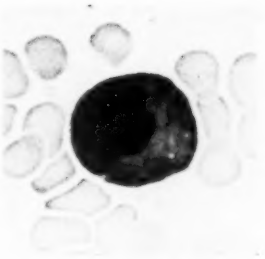
2. A group of early polymorphs. × 1,300.



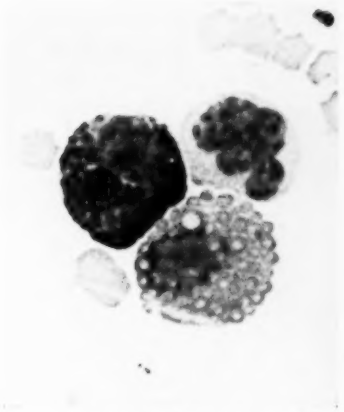
3. A myeloblast and two early polymorphs. × 1,300.



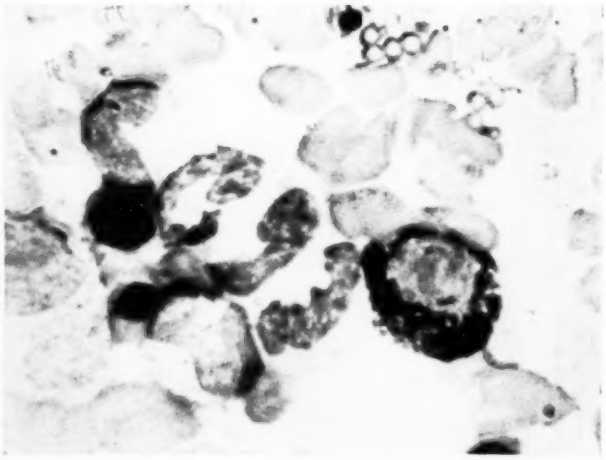
4. A proerythroblast for comparison with the myeloblast shown in figure 3. Note the "hoff" which is an area of cytoplasm that does not take up basophilic stain. × 1,300.



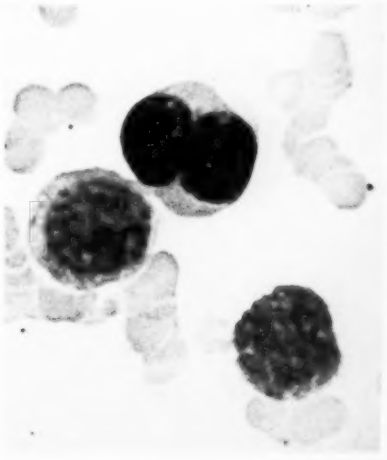
5. A plasma cell. × 1,300.



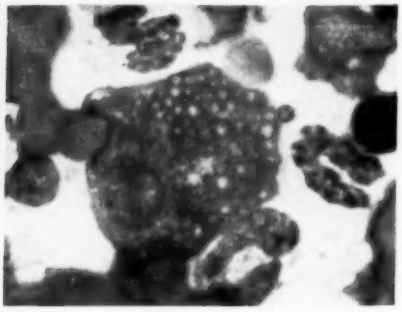
6. A group of adult polymorphs—eosinophil, basophil and neutrophil. × 1,300.



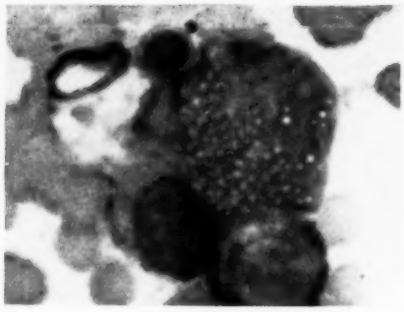
7. A group of two metamyelocytes, three polymorphs and a basophil. × 1,300.



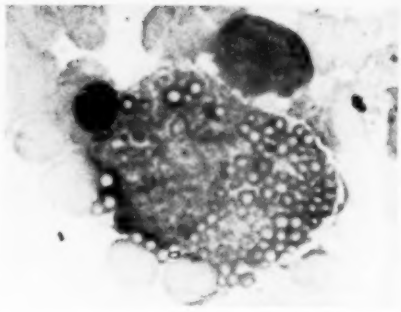
8. A late normoblast (type C) in mitosis with an intermediate normoblast (type B). × 1,300.



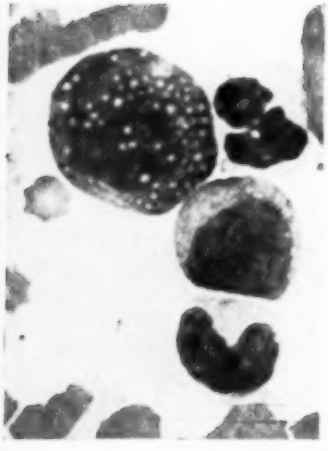
9. An eosinophil promyelocyte. × 1,300.



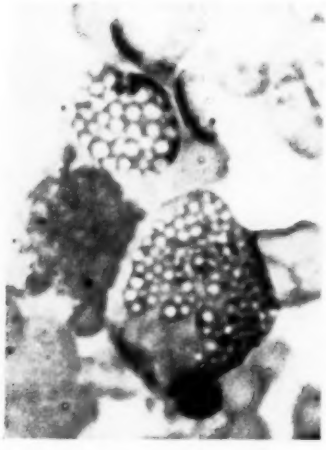
10. Eosinophil myelocytes. × 1,300.



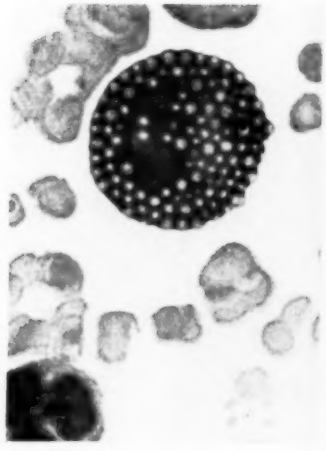
11. Eosinophil myelocytes. × 1,300.



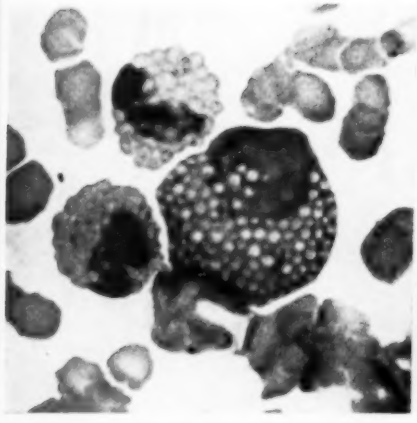
12. Eosinophil myelocytes. × 1,300.



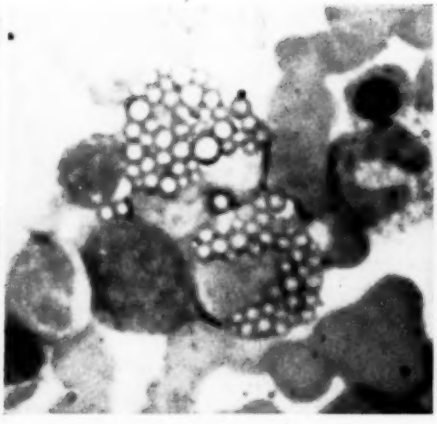
13. Eosinophil metamyelocyte. × 1,300.



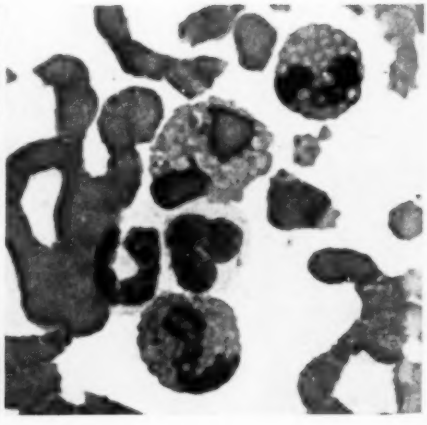
14. Young eosinophil polymorph. × 1,300



15. Adult eosinophil forms. Note differing granule size. × 1,300.



16. Adult eosinophil forms. Note differing granule size. × 1,300.

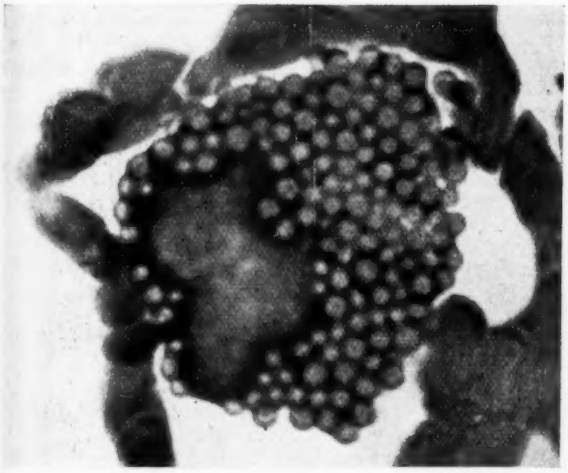


17. Late adult eosinophils (above). × 1,100.

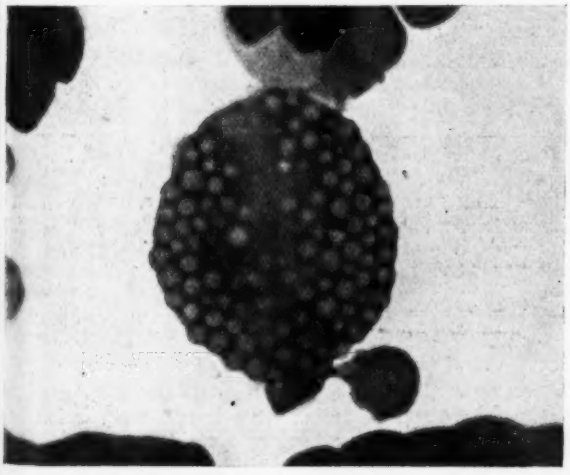
Table IV

Date of birth	Weight in lb.	Breeding	Sex	Total nucleated cell count	M:E ratio : 1	Differential cell count as per cent.															Mitosis per 1,000	Megakarryocytes per 10,000
						Polymorphonuclear			Metamyelocyte			Myelocyte		Promyelocyte	Myeloblast	Lymphocyte	Plasma cell	Normoblast			Proerythroblast		
						N	E	B	N	E	B	N	E					Late	Intermediate	Early			
6/53	269	Shetland ×	F.	312,000	1·8	10·1	1·22	0·0	20·2	2·61	0·17	14·4	0·69	0·17	0·0	4·35	0·69	27·5	13·0	3·3	0·69	7	<1
5/53	231	Shetland ×	M.	223,000	1·9	11·1	1·64	0·0	17·9	2·62	0·99	28·6	1·31	0·99	0·66	2·46	0·48	20·0	11·66	2·13	0·99	6	4
5/53	282	Shetland	F.	167,500	2·94	12·0	1·68	0·0	21·4	2·38	0·14	27·2	2·1	0·84	0·42	5·3	0·42	16·5	6·3	1·68	0·42	11	<1
5/53	252	Shetland ×	M.	228,000	1·1	11·9	0·84	0·0	15·4	1·34	0·50	21·6	1·34	0·34	0·34	2·85	0·34	39·2	9·4	2·68	0·34	16	<1
10/52	311	Shetland	M.	142,000	2·4	13·5	3·32	0·0	17·95	2·33	0·5	22·3	1·66	0·33	0·16	10·8	1·66	17·3	5·65	1·83	0·0	7	<1
9/52	422	Welsh ×	F.	23,100	5·5	18·3	2·48	0·0	23·1	8·0	0·78	15·3	1·93	0·39	0·0	13·1	0·0	10·3	3·09	1·55	0·0	1·5	<1
5/52	340	Welsh ×	F.	25,360	6·4	17·75	5·95	0·28	24·9	3·46	1·25	17·75	2·35	0·55	0·28	13·3	0·69	8·17	2·21	0·55	0·14	4	<1
4/52	344	Shetland ×	M.	55,000	3·2	15·9	3·44	0·0	21·8	5·39	0·65	11·46	0·82	0·33	0·0	20·9	0·16	13·9	2·78	1·84	0·33	8	8
1948	564	Shetland	F.	—	4·2	18·7	1·25	0·0	25·5	1·25	0·625	20·5	0·78	0·78	0·31	12·7	0·63	13·6	2·98	0·16	0·0	2	4
1946	678	Shetland ×	F.	107,000	3·5	14·2	2·78	0·33	22·1	6·2	5·39	12·75	1·47	0·82	0·33	12·9	0·33	12·1	5·55	0·82	0·33	3	3
1945	952	Exmoor ×	G.	—	1·2	7·83	0·32	0·0	22·1	1·05	0·35	12·2	0·69	0·35	0·35	8·35	1·05	28·5	11·0	4·35	0·87	6	<1
1937	698	Shetland, Shire ×	F	29,000	10·2	25·3	5·5	0·0	29·4	6·95	0·58	11·4	2·03	0·14	0·0	9·55	0·29	4·2	2·46	1·89	0·0	2	2

Equine marrow cell differential counts.

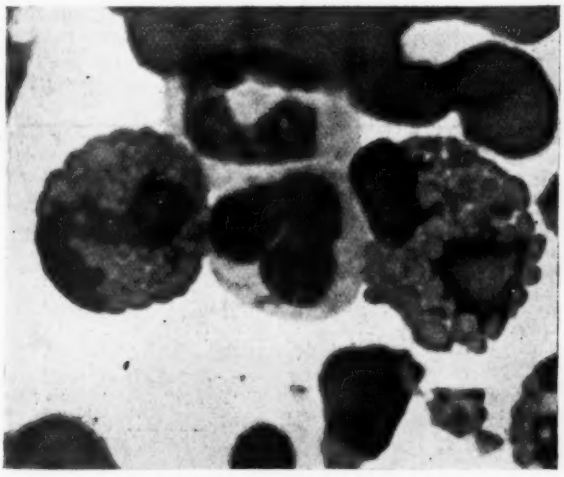


18. Eosinophil myelocyte. × 2,000.



19. Eosinophil metamyelocyte. × 2,000.

the eosinophil stain and indeed some few stain basophilic. Bloom & Wislocki (1950) suggest that there are two types of eosinophil granules in normal human patients, as seen by using Baker's (1946) acid haematin stain. With Sudan Black, the eosinophil granules appear to be coated with a sudanophilic substance, but have a centre of a sudanophobic substance. This was noted by Hayhoe (1953) and is strikingly evident in the horse. Some granules, however, appear to consist entirely of a sudanophilic substance and it may be that this staining reaction compares with the occasional basophil stained granules seen in Leishmann preparations.



20. Adult eosinophil forms. × 2,000.

Acknowledgments.—My thanks are due to Sir Lionel Whitby, Regius Professor of Physic, for his advice and for permission to publish this paper which is a preliminary study made at the Department of Medicine, Cambridge University, as a research student. I acknowledge my indebtedness to Dr. F. G. J. Hayhoe of the Department of Medicine, who has given constant advice and help and has checked some of the differential marrow counts here given. My thanks are also due to Mr. Wm. C. Miller, Director of the Equine Research Station of the Animal Health Trust, for his advice and for making the experimental ponies used available to me.

The work has been performed during the tenure of an Equine Research Fellowship of the Animal Health Trust.

(*Continued at foot of col. 1, page 264*).

FOETAL ATROPHY IN THE BUFFALO

BY

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Introduction

Foetal atrophy occurs normally in multiparous species such as the pig (Hammond, 1921; Corner, 1923; Warwick, 1928), and the rabbit (Hammond, 1928), where there is a surplus in the production of the female gametes. The phenomenon is more frequent in inbred animals than outbred ones; heavy prenatal mortality being characteristic of the mother and not of the embryo as shown by Pomeroy (1952). The higher conception rate of beef cattle than dairy cattle is attributed to higher mortality rate in the latter breeds due to inbreeding (Hammond, 1950). In uniparous and diparous species, high foetal mortality follows hormone-induced superovulations as shown in the cow (Hammond & Bhattacharya, 1944; Zawadowsky, 1941) and in the ewe (Robinson, 1951). Meanwhile, foetal atrophy results sometimes from specific environmental conditions. Mineral imbalance sometimes causes luteal deficiency (as a result of poor quality corpus luteum of pregnancy) with subsequent embryonic death (Hignett, 1949). It also occurs as a symptom of enzootic sterility associated with *Vibrio foetus* (Sjollema *et al.*, 1949; Stegenga, 1950).

Recent reports on infertility of cattle (Casida *et al.*, 1946; Barrett *et al.*, 1948; Milk Marketing Board, 1950) and of the buffalo (Hafez, 1952a, b, 1953) have dealt with the irregularity of periodicity with particular reference to the suppression of oestrus after unsuccessful mating. In the buffalo the pregnancy period is longer than that in cattle, being some 314 days in the former (Hafez, 1952c). Large losses due to sterility occur every year in the buffalo in many countries.

The following investigation was designed to obtain information concerning foetal atrophy in the domestic buffalo (*Bos* (*Bubalus*) *bubalis L.*). The possible changes in the genitalia and in the placenta due to this phenomenon were considered during early and mid-pregnancy.

Materials and Methods

Fifty pregnant and 24 non-pregnant genitalia of Egyptian buffaloes were available. The previous history of the animals was unknown. The exact date of conception was not known, but the approximate age of pregnancy was determined by the weight and diameter of the foetus (the diameter being more accurate than weight in determining the age of pregnancy). The animals were slaughtered during March and April, 1953, at Cairo slaughterhouse, and the reproductive organs were removed for dissection and examination. Genitalia from immature animals and genitalia with anatomical abnormalities were excluded. The side of the most recent ovulation was recorded, also the site of the foetus. The ovaries were weighed and examined macroscopically. The thickness of the ovary varied very much with the size and position of the corpus luteum and with the degree of prominence of the rupture point; this was not recorded. A thin central longitudinal section was made through the ovaries with a sharp razor. Notations were made on the internal structure with particular reference to the number and diameter of the growing follicles and of the functioning and old corpus luteum. The size (average diameter) of the graafian follicle and the corpus luteum was considered as the mean of three diameters:—

(i) Length, including the protrusion from the ovarian surface.

(ii) Width at right angles to (i).

(iii) At 45° to (i), this was done to the two halves of the ovaries exposed by the section.

The uterus was then freed from fat and connective tissues except the attached parts of broad ligament, the vagina being cut off at the external os. The uterus with its contents and the cervix were weighed. The two uterine horns were dissected from each other (there was no body uterus) and from the cervix at the internal os. The uterus was dissected and the contents were carefully examined. Notations were made concerning the weight and shape of foetus, foetal fluids, foetal membranes and the cotyledons. The gravid and non-gravid horns and the cervix were examined and weighed.

Samples were taken for histological studies (serial sections) and the specimens were preserved in 10 per cent. formalin. When material accumulated, it was photographed. The colour of the corpora lutea disappeared by oxidation when preserved, and they were painted with Indian ink before photography. This work has been carried out at the Animal Breeding Department, Faculty of Agriculture, Cairo.

Results

The conceptus

In all the pregnant animals the foetus was carried in the uterine horn corresponding to ovulation, there was no evidence for ova immigration. During recent, early and mid healthy pregnancy the foetus weighed from 0·7 to 1,541·7 grammes and the diameter ranged from 1·2 to 32·2 cm. The foetal fluids ranged from 62 to 3,510 grammes whilst the foetal membranes ranged from 12 to 700 grammes (Table I). Four types of foetal atrophy including seven cases were recorded out of 50 cases of pregnancies.

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TABLE I

THE WEIGHT OF UTERINE CONTENTS DURING FOETAL ATROPHY AND HEALTHY PREGNANCY

Condition	Type	No. of cases	Foetus		Foetal fluids	Foetal membranes
			Weight	Diam.		
			Gm.	Gm.	Gm.	Gm.
Foetal atrophy	I	3	—	—	30*	—
	II	2	1·9	0·6	51*	24
	III	1	96	16·9	400*	10
	IV	1	6†	4·0†	6*	—
Healthy pregnancy	Very recent	4	0·7	1·2	62	12
	Recent	14	4·2	3·5	145	44
	Very early	16	97·5	12·9	675	203
	Early	5	282·3	19·1	1,258	345
	Mid	4	1,541·7	32·2	3,510	700

* Foetal fluids completely reabsorbed and the figures represent the weight of the debris and disintegrating blood.
† Foetal remains.

Type I.—This represented foetal atrophy in a very recent or recent stage of conception. The uterus contained a viscous debris with a yellowish colour and a disagreeable smell denoting the occurrence of putrefaction. Traces of the foetus or the foetal membranes were hard to detect. The debris was more abundant in the gravid horn (corresponding to the corpus luteum of pregnancy) than in the non-gravid. The uterine contents varied in weight from 20 to 43 grammes. The endometrium, after washing with tap water, resembled that of non-pregnant animals.

Type II.—This represented foetal atrophy in very early pregnancy. The foetus, amnion, allantois and chorion were easily defined. Degeneration was observed at the necrotic tip in the non-gravid horn; this end was associated with the smell of putrefaction. The foetal fluids were completely reabsorbed in the non-gravid side, whilst in the gravid side they filled the membranes and did not rupture (Fig. 1). Foetal attachments were not yet developed. The foetus weight was similar to that of the corresponding age in healthy pregnancy, whilst the foetal fluids and foetal membranes were less. The appearance of the endometrium did not show any lesion-like areas in both horns.

FIG. 1.—Foetal atrophy of type II. Degeneration in foetal membranes in the non-gravid horn. Foetus not yet degenerated. Foetal fluids were reabsorbed in the non-gravid side only. (Scale: cm.)

Type III.—This was an advanced case of degeneration in a foetus during mid-pregnancy (foetus diameter 16·9 cm.). The foetus was surrounded with a large mass of dark brown debris making a vast coagulum. Some blood clots were

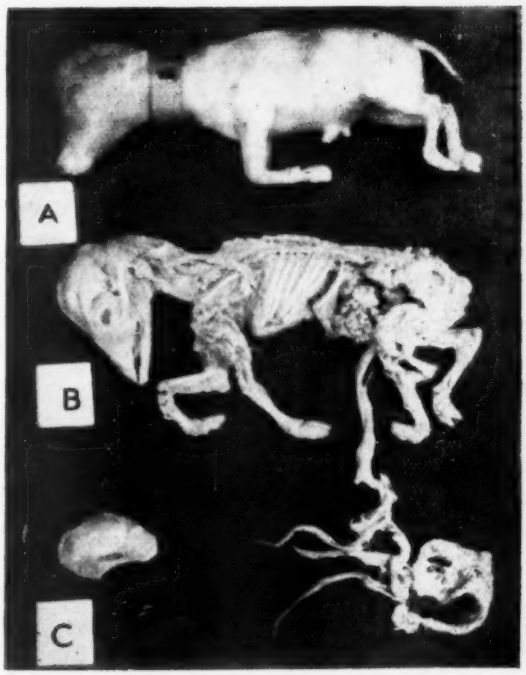

FIG. 2.—A—Healthy foetus of a similar age to B. B—Atrophied foetus of type III. Note the remains of foetal membranes attached to umbilical cord. C—Foetal remains after atrophy of type IV. Note the shell-shaped cartilage tissue taking the shape of the far end of uterine cavity. (Scale: cm.)

disintegrating whilst the foetal fluids were completely reabsorbed. The foetal membranes were completely degenerated leaving behind a dry cadaver weighing 10 grammes and attached to the umbilical cord. The foetus weighed 96 grammes and the debris weighed 400 grammes. The skin and muscular coat of the foetus were completely degenerated while the skeletal system, internal organs (viscera) and eyes were not attacked (Fig. 2b). The non-gravid endometrium had the appearance of a non-pregnant

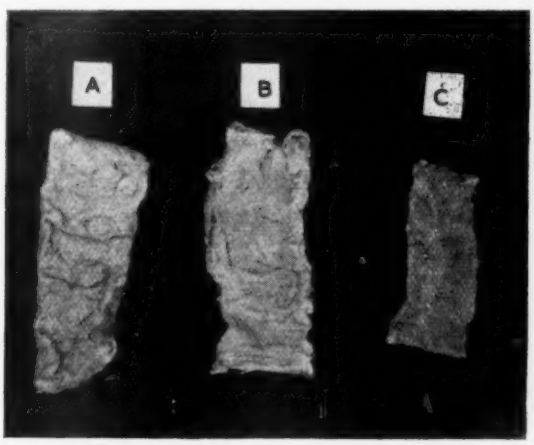

FIG. 3.—Endometrium A—Gravid horn of foetal atrophy type III. Note the chorionic villi still attached to maternal cotyledons. B—Non-gravid horn of foetal atrophy type III. Note its normal macroscopical appearance which resembled healthy non-pregnant endometrium (C). (Scale: cm.)

horn, the maternal cotyledons were regressed. In the gravid horn, however, the maternal cotyledons were still developed but not to the same height as in the corresponding healthy pregnancy. The foetal membranes had left behind the chorionic villi still attached to the maternal cotyledons (Fig. 3).

Type IV.—This was the most advanced case of atrophied foetus. Atrophy seemed to have started either in recent or very early stages of pregnancy (after developing the cartilage tissues of the foetus). The uterus contained the foetal remains, a piece of shell-shaped cartilage (Fig. 2c) and a mass of putrefied brownish debris. The shell-shaped remains were situated in the gravid horn at the anterior extremity (near the fallopian tube). This shape was similar to the uterine cavity at that situation.

Fig. 4.—Ovaries (cut longitudinally and represented into halves) to show the corpora lutea which were painted with Indian ink. A—Non-pregnancy. B—Healthy pregnancy. C—Foetal atrophy of type III. D—Foetal atrophy of type IV. R—Right; L—Left. The corpora lutea are invaded in the ovarian stroma in the cases. The size of the corpus is smaller in cases of foetal atrophy than in non-pregnancy and healthy pregnancy. (Scale: cm.)

The reproductive organs

The most recent corpus luteum was in the right ovary in 75 per cent. of all the cases studied (non-pregnancy, healthy pregnancy and foetal atrophy). The weight of the ovary with the last corpus luteum varied from 4·3 to 6·8 grammes during non-pregnancy, from 5·3 to 5·9 grammes during healthy pregnancy (recent to mid) and from 3·7 to 4·1 in cases of foetal atrophy. The weight of the ovary without corpus luteum varied from 3·7 to 4·4 grammes during non-pregnancy, from 2·2 to 3·9 grammes during healthy pregnancy and from 2·7 to 3·7 in cases of foetal atrophy. In general the weight of the ovary with the corpus luteum was much lighter than that without corpus luteum (Table II). There was no significant difference beween the ovarian weight during non-pregnancy and healthy pregnancy (when all the cases were grouped under the two items). The ovarian weight in the cases of foetal atrophy was lighter than that during healthy pregnancy and non-pregnancy. Statistical analysis was impossible due to the small number of cases.

The average diameter of the most recent corpus luteum during non-pregnancy varied from 1·0 to 1·5 cm. according to the stage of the oestrous cycle. During healthy pregnancy the average diameter was almost 1·9 cm.; it was as big as 2·2 cm. in some individuals. In cases of foetal atrophy, the average diameter ranged from 1·6 to 1·7 cm. It was slightly smaller than that during healthy pregnancy (Fig. 4).

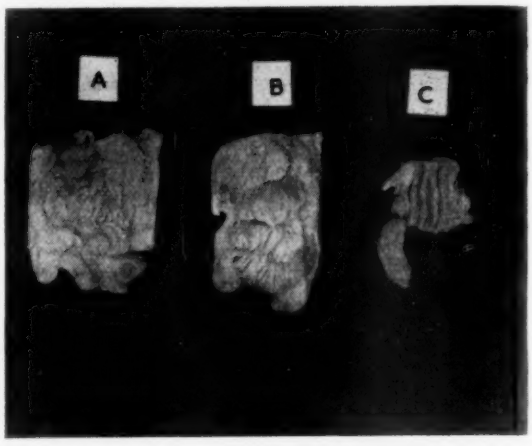

Fig. 5.—Cervix cut open to show outgrowth ridges. A—Non-pregnancy. B—Healthy pregnancy. C—Foetal atrophy of type III. Cervix C is lighter and shorter than A and B, the ridges are abnormal, which result in non-constriction. (Scale: cm.)

The corpus luteum was invaded in the ovarian stroma in all the ovaries observed irrespective of the reproductive phase of the animal. The corpus luteum of pregnancy in cases of foetal atrophy did not differ macroscopically from that during healthy pregnancy, in respect of shape, texture, colour and organisation of blood vessels.

Developing graafian follicles were observed in both ovaries in the three categories of animals under consideration. Such follicles were more frequent and had larger diameter in the ovary without corpus luteum than in the other ovary. In the ovaries without functioning corpora lutea, the largest developing graafian follicle ranged from 0·8 to 1·3 cm. during non-pregnancy, from 0·4 to 0·9 cm. during healthy pregnancy, and from 1·0 to 1·2 cm. in cases of foetal atrophy. There was no difference in the average diameter. During healthy pregnancy and foetal atrophy there were series of developing graafian follicles which did not reach the stage of rupture but degenerated as shown by the presence of luteal scars.

The two uterine horns were attached together to the broad ligament, they seemed to be united. Actually, the two uterine horns were completely separated and there was no uterine body. During non-pregnancy the maternal cotyledons were placed in four to six rows on the endometrium. The height of these cotyledons, which was very slight, varied with the stage of the oestrous cycle. With the onset and advancement of healthy pregnancy, the height and the surface area of the cotyledons increased. The weight of the uterine horn in the non-pregnant animal varied from 211 to 260 grammes with no difference between the right and left horns. During healthy pregnancy the gravid horn weighed from 247 to 1,200 grammes whilst the non-gravid weighed from 220 to 625 grammes. The gravid horn was consistently heavier than the non-gravid, the difference being higher with the advancing pregnancy. In cases of foetal atrophy the gravid horn weighed from 222 to 690 grammes while the non-gravid weighed from 233 to 340 grammes. The difference between the two horns was less than that during healthy pregnancy.

The cervix consisted of outgrowth ridges arranged in two to six rows. The size of these ridges varied with the stage of the oestrous cycle and of pregnancy. During healthy pregnancy the cervix was very much constricted and contained a mucous plug of gelatinous secretions.

Table II
The Average Weights and Diameters of the Major Reproductive Organs

Condition	Case	No. of animals	Ovaries		Diameter of last C.L.	Follicle diameter in ovary without last C.L.		Uterine horns (empty)		Cervix	
			With last C.L.	Without last C.L.		Largest	Next largest	Gravid	Non-gravid	Weight	Diameter
			Gm.	Gm.	Gm.	Cm.	Cm.	Gm.	Gm.	Gm.	Cm.
Foetal atrophy	I	3	3·9	2·9	1·6	1·0	0·5	222	233	37	4·2
	II	2	4·1	3·7	1·6	1·0	0·7	231	240	34	4·7
	III	1	3·7	2·8	1·7	1·2	0·9	690	330	32	3·3
	IV	1	3·8	2·7	1·7	1·2	0·8	420	340	39	4·4
Healthy pregnancy	Very recent	4	5·9	3·9	1·9	0·9	0·4	247	220	50	5·3
	Recent	14	5·3	3·9	1·9	0·8	0·5	209	238	57	6·1
	Early	16	5·5	3·5	1·9	0·9	0·5	401	279	58	6·1
	Very early	5	5·4	2·2	2·2	0·8	0·5	1,000	575	61	6·1
	Mid	4	5·6	2·7	1·9	0·4	0·4	1,200	625	273	11·0
Non-pregnancy	Early-di*	6	6·8	4·4	1·2	0·8	0·1	239	232	59	5·3
	Mid-cycle	10	5·2	2·7	1·5	1·3	0·1	227	211	50	6·0
	Late-di†	8	4·3	3·5	1·0	1·8	0·1	242	260	42	5·2

* Early dioestrus or metoestrus.
† Late dioestrus or proestrus.

During non-pregnancy the cervix weighed from 42 to 59 grammes and the length ranged from 5·2 to 6·0 cm. During healthy pregnancy it weighed from 50 to 273 grammes according to the stage of pregnancy. It varied in length from 5·3 to 11·0 cm. In cases of foetal atrophy the cervix was not constricted although it contained the mucous plug. It weighed from 32 to 39 grammes and its length varied from 3·3 to 4·7 cm. In general it was lighter and shorter than that during non-pregnancy or healthy pregnancy. Fig. 5 shows the abnormal outgrowth ridges and the abnormal short cervix which resulted in non-constriction.

Discussion

It is concluded that foetal atrophy starts at different stages of pregnancy. In recent stages of pregnancy the degenerating conceptus is reabsorbed rapidly, while in later stages the foetal membranes disappear before the foetus. The foetal tissues degenerate at different rates, the remainder being the cartilage. In the buffalo, pregnancy is diagnosed by rectal palpation after 60 days and the characteristic feel of the uterine horn and the identification of the foetal membranes. In certain cases, pregnancy is diagnosed and not confirmed on later examination, with subsequent absence of calving (Hafez, 1953a). This confirms the occurrence of foetal atrophy *in situ* in this uniparous species. The endometrium after complete foetal absorption seems to be normal in colour and in appearance. The black pigments which resulted from the disintegrating blood (which is often observed in the pregnant endometrium of the ewe) disappear when the coagulum is absorbed. Whether or not foetal atrophy is characteristic of certain individuals is of great practical importance in selective breeding. The effect of age on the incidence of foetal atrophy is of no little interest also.

The life of the corpus luteum is maintained for a long time throughout the oestrous cycle. During all cases of healthy pregnancy studied, the corpus luteum is maintained at its maximum. During cases of foetal atrophy the diameter of the corpus luteum is less than that during healthy pregnancy. This suggests that a deficiency in the progesterone production for the normal requirements may be a possible cause for foetal atrophy. It is concluded that this phenomenon is not associated with the regression of the corpus luteum of pregnancy. This explains the suppression of oestrus after unsuccessful pregnancy. It is not possible in the present study to make an accurate estimate of the incidence of embryonic death in the buffalo.

Another cause of foetal atrophy is not observed in practice under normal breeding conditions. Breeding puberal animals at their first oestrous cycle requires more than one service per conception and there is often irregularity in the cycle length as reported in sheep (Hafez, 1953b, 1954) and in the buffalo (Mansour, 1953). Also breeding at the first *post-partum* oestrous cycle is associated with oestrous irregularities as shown in sheep (Hafez, 1954) and in the buffalo and cow (Hafez, 1952d). In the previously mentioned cases, fertilisation may have occurred followed by foetal atrophy due to unprepared endometrium.

Laing (1945, 1949) when examining 48 *post-mortem* genitalia of normal beef heifers, found three had a uterus containing only foetal membranes with no embryo but with apparently normal corpus luteum of pregnancy in one ovary. In clinically normal infertile cows the embryonic death-rate at 34 days after conception is 65·1 per cent. (Tanabe & Casida, 1949). In the present investigation, foetal atrophy is associated with an anatomical abnormality, a short and not constricted cervix. It is possible that this causes an inclusion of atmospheric air in the uterus with subsequent bacterial infection. Whether foetal atrophy is due to a deficiency of some special substance in the blood or whether it is due to a disturbed balance of the gonadic, gonadotrophic or placental hormones, is not yet known and awaits further evidence. It is possible that it is due to a defect in the spermatozoon or ovum at the time of fertilisation, or to unsuitable tubal or uterine environment. In this connection, Laing (1949) and Casida (1950) postulate that the most likely defect in the ovum is ageing. It should be mentioned here that the time of ovulation in relation to oestrus is still unknown in the buffalo. It is possible that under free mating conditions in this species, conception from old-aged ova results in subsequent embryonic mortality. This point is worth investigating in species of long duration of oestrus such as the mare. The most striking feature revealed from the present observations is that the normal pregnancy rate does not represent the fertilisation rate nor the conception rate, which are obviously much higher.

Foetal atrophy has been recorded in human beings in many instances, such as extra-uterine pregnancy and *foetus compressus*. In the latter case, uniovular twins (identical twins) are followed by the formation of one placenta; and if the heartbeats are slower in one of the twins it undergoes degeneration. At parturition the degenerated foetus is expelled with the placenta. The former has a diameter of some 4 cm. A healthy newborn baby has a diameter of some 49 cm. (Fahmy, 1953).

Further investigations are urgently needed to estimate the frequency of foetal mortality after the first and subsequent services. Since this phenomenon is associated with a number of conditions of different aetiology, certain factors should be either included or excluded when evaluating concrete evidence. It is possible that the segmenting ova degenerates very early before mid-cycle without affecting the animal's own return to service. The possibility of unseen abortion or of the pathological infections (*Trichomonas foetus* and *Vibrio foetus*) must be kept in mind. The effect of preventive vaccines, given as a routine, on inducing foetal atrophy in pregnant buffaloes is of major importance in veterinary obstetrics. If means could be found to reduce this embryonic death-rate appreciably, it should be possible to raise the fertility level of the buffalo.

Summary

Fifty pregnant and 24 non-pregnant buffalo genitalia were dissected to determine the possible incidence of foetal atrophy.

Four types of foetal degeneration were recorded, these occurring at different stages of pregnancy.

The endometrium had the normal colour and appearance after complete foetal absorption.

Foetal atrophy was associated with a smaller corpus luteum and a shorter cervix than those of healthy pregnancy.

This phenomenon was not followed by the regression of corpus luteum of pregnancy; this explains the suppression of oestrus after unsuccessful pregnancy.

The normal pregnancy rate does not represent the fertilisation rate nor the conception rate in this uniparous animal.

The different factors involved in foetal atrophy are augmented whilst further studies in this field are considered.

Acknowledgments.—Thanks are due to Professor A. L. Badreldin for accommodation in his department during the course of the work, to Mr. M. M. Mansour for supplying some of the material, and to Mr. I. Fouad for photographic assistance.

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REVIEW

[Animal Nutrition Research in India. By K. C. Sen. (1953). Calcutta: Macmillan Co., Ltd. 25s.]

Dr. K. C. Sen, Director of the Indian Dairy Research Institute, Bangalore, from which much important work has emanated for some decades, has written this book on Animal Nutrition Research in India. It is issued by the Indian Council of Agricultural Research, the body responsible for the organisation of veterinary as well as of agricultural research in India, other than that done by provincial organisations.

Sir John Russell, former Director of Rothamsted Station, visited India and wrote a report in 1937 on the work of that Council in applying science to crop production in India. He commented that much of the research on agricultural science in India was not as widely known as it deserved to be, and he recommended the preparation of a series of critical monographs setting forth the results obtained. This book is one of a series issued with that end in view.

The author states that the book was originally prepared in 1943 when he was Officer-in-Charge, Animal Nutrition Section, Indian Veterinary Research Institute, Izatnagar, and that the original script has been revised.

There are 11 chapters, as follows: An outline of agriculture and animal husbandry in India; chemical composition of Indian feeding-stuffs; digestibility and nutritive value of Indian feeding-stuffs; proteins, sulphur and energy metabolism of animals; mineral metabolism of cattle; conservation and processing of fodders and the use of certain plants and tree leaves as scarcity fodders; the feeding value of some industrial by-products; investigations on poisonous plants and toxic minerals; investigations on the blood composition of some animals; studies in vitamins and deficiency diseases; investigations in dairy science.

The book is a very useful source of reference on matters concerning work on these subjects in India. There is a useful glossary of certain terms used, largely of Indian names and an author index, but no subject index.

CLINICAL COMMUNICATION

DISPLACEMENT OF THE BOVINE ABOMASUM

H. F. HEBELER,

Langport

Subject.—Pedigree attested Friesian heifer in milk, calved six weeks, a heavy milker.

History.—The first visit was made on account of severe lameness in the right hind leg. Foul-in-the-foot was diagnosed but the condition responded very slowly to treatment and the animal was acutely lame for 10 days having considerable difficulty in rising to her feet. Owing to shortage of accommodation, she had to be kept tied by a yoke in a double standing which had rather a high double step down into the gutter. A week after the first visit she was found to have a slight tympany. This was thought to be due to excessive concentrate feeding in an endeavour to keep the milk-yield up; advice based on this supposition was given. At the next visit, 48 hours later, the tympany was found to have increased and the animal was obviously ill.

Symptoms.—The general appearance was dull with back slightly arched and coat rough; there was a considerable degree of tympany which was also obvious on the right side; temperature was normal, pulse 90, respirations 20. Defaecation was frequent, the quantities small, consistency normal. The animal ruminated occasionally for short periods and there was fairly frequent eructation of small quantities of gas.

Rectal examination did not prove very helpful as the rectum appeared to be floating in the abdominal cavity, giving a feeling of negative pressure; nasal passage of the stomach tube did not relieve the tympany or reveal any obstruction in the oesophagus or reticulum. The tympany was confirmed as being ruminal in origin by the insertion of a hypodermic needle in the left flank and the demonstration of methane in the issuing gas.

Diagnosis.—A tentative diagnosis of actinobacillosis of the reticulum was made; this condition is a common cause of chronic limited tympany in the district.

Treatment.—Two ounces of sodium iodide dissolved in 400 c.c. distilled water was administered intravenously. The animal was seen again five days later and it was found that the tympany was slightly greater and the general appearance worse; appetite was almost absent, temperature 103·5, pulse 120, respirations 24, defaecation had ceased. A thorough check for the presence of a foreign body gave a negative result; the passage of the stomach tube was again unhelpful, except to administer an antizymotic and laxative dose. Further doses were left for oral administration. Next day there was still no improvement, except for some defaecation, and the animal was obviously becoming weaker. Examination revealed slight signs of peritonitis in the region of the xiphisternum. It was decided to carry out exploratory laperotomy without delay.

Operation.—Left flank laperotomy was carried out in the standing position with paravertebral anaesthesia. On entering the abdominal cavity, the rumen was found to be collapsed, only about one-third full of solid matter and lying in the mid-line. Between its left surface and the abdominal wall was the abomasum, lightly distended with gas. The greater curvature of this organ faced dorso-laterally, the fundus passing back to the right side under the reticulum, the pylorus was directed ventro-laterally to the right and its continuance as duodenum could be clearly felt passing ventral to the rumen, half-way along its length. Very considerable adhesions were present where the abomasum was in contact with the left abdominal wall, about one-third up the length of the 10th rib. After careful exploration and a fruitless attempt to replace the abomasum in its normal position, it was decided to break down the adhesions; this was achieved quite easily with little sign of pain from the patient until a final area the size of a 5s. piece was left. Here the adhesions were very strong and fibrous, and during their break-down rupture of the abomasum occurred and the abdominal cavity was immediately flooded with its watery contents. This took place so rapidly that it was impossible to attempt repair of the rupture and, in any case, it was considered that, with adhesions of such severity, they would soon recur. Before destruction was carried out it was found that the abomasum, now completely collapsed, could be restored to its rightful place quite easily.

Discussion

This case is recorded in the hope that it may be of assistance to veterinary surgeons confronted with obstinate chronic tympany where there is no likelihood of tuberculous mediastinal glands, and to encourage exploratory laperotomy at a stage earlier than was carried out in this case, when doubtless the adhesions would not have been so severe.

The condition has been recorded previously, usually as a differential diagnosis of traumatic reticulitis; chronic tympany as a symptom appears to be rare, but where it does occur the suggestion of "negative pressure" on rectal examination is regarded as characteristic, as it is also in the condition described as torsion of the abomasum. It has been suggested that the cause of the condition is a violent slip when rising and this might well have occurred in the case recorded above, especially in view of the rather unusual and awkward construction of the floor of the cow-stall.

THE MAMMAL SOCIETY OF THE BRITISH ISLES

At a Conference held at the University of Birmingham on April 23rd to 26th, a new scientific society, to be known as "The Mammal Society of the British Isles" was brought into being. Those present were welcomed by Professor S. Zuckerman, C.B., F.R.S., who emphasised the reciprocal value of field studies and experimental work and expressed the opinion that the new society would prove of great help to those using mammals in the laboratory. This theme was elaborated by A. N. Worden, of Huntingdon, in his opening paper on "The Study of Mammals," which dealt also with the need for codifying the scattered information on British mammals, with various aspects of current research and with co-operation between mammalogists and those engaged in agriculture, forestry, pest control, conservation, veterinary science and human medicine. Other papers given at the conference dealt with small mammals (H. N. Southern, Bureau of Animal Population, Oxford), bats (M. Blackmore and J. H. D. Hooper), shrews (Peter Crowcroft, Infestation Control Division), seals (R. M. Lockley, Nature Conservancy), badgers (E. G. Neal and H. R. Hewer, Imperial College, London) and the work of Merlewood Research Station by its Director, Dr. K. R. S. Morris.

The following officers were appointed: President, the Earl of Cranbrook; Chairman, Alastair N. Worden; Hon. Secretary of Scientific Advisory Committee, H. N. Southern; Hon. Treasurer, H. G. Hurrell; and Hon. Secretary, T. J. Pickvance, Department of Extra Mural Studies, University of Birmingham, Edmund Street, Birmingham, 3.

It is to be hoped that members of the profession will join the Society, the activities of which will, as was made clear at the Conference, include much that is of interest to them. The annual subscription has been fixed at one guinea, and further details may be obtained from the Hon. Secretary at the address given.

REPORT

[Annual Report of the Veterinary Department, Bechuanaland Protectorate, for the year 1952.]

In Bechuanaland the most serious obstacle to progressive livestock development is not epizootic disease but scarcity of water and food. Lack of water forces cattle owners on to the better grazing areas in the vicinity of rivers and streams, where the land becomes overgrazed and the cattle exposed to tsetse-fly infection. Much of this report by the Director of Veterinary Services (Mr. J. E. R. Roe, M.R.C.V.S.) is an account of the problems of animal husbandry in a country of low rainfall, sparse and poor quality pasturage, primitive methods of animal husbandry and limited export resources.

The need for advancing the livestock industry is apparent from the fact that of the total exports from the country 92 per cent. are of animal origin, mainly beef. Good markets for beef exist in the adjoining territories of Northern and Southern Rhodesia and the Union of South Africa. In the interests of an improved internal economy the livestock industry must be improved and developed.

In 1952 the cattle population of the territory numbered 1,054,296, a slow but gradual increase since the census of 1943; an increase all the more significant because obtained in spite of the annual exports of livestock and the heavy losses each year from sheer starvation.

In one area alone (Kange) it is stated that nearly 6,000 cattle died of poverty; and the Director of Veterinary Services thinks that this estimate should be doubled.

While the provision of more watering facilities would open up new areas for grazing, this would not be the final solution of the problem of food shortage. It would be necessary also, as the Director points out, to improve the type of pasturage and grow fodder crops.

In this connection the system of native land tenure must be revised so as to give greater security to farmers to institute improvements such as fencing, tick eradication, increased land fertility and housing.

The Colonial Development Corporation have holding ranches in the Protectorate, and an abattoir, where the sound and immediate advantages of a policy of improved feeding and pasture management of existing indigenous stock can be demonstrated, as against the long-term policy of stock improvement by breeding, with results less well defined and more problematical.

Losses in these ranches have been heavy and during the year 1,800 head of cattle died of disease, accident and poverty. Probably with closer veterinary control and supervision these losses could be greatly reduced by attention to the control of tick-borne and other diseases.

Disease.—The measures which were outlined in a previous report for the control of foot and mouth disease are being implemented, and the erection of a fence 150 miles long is making good progress. No outbreaks of this disease occurred during the year.

Rinderpest is not a problem in Bechuanaland. Other diseases are tackled by vaccination and anti-tick measures. Heartwater takes a heavy toll of sheep and goats. In one area alone 3,856 small stock died of the disease.

The treatment of trypanosomiasis with dimidium bromide is carried out in infected areas with success and growing popularity. But the basic method of control of this disease must continue to be the provision of watering facilities in tsetse-free areas and bush clearing in infested ones.

Aphosphorosis botulism is a serious disease condition in Bechuanaland. The shortage of phosphorus is very acute in the pasturage, a situation which is greatly aggravated by the serious shortage of bone meal, which is used to combat the condition. Superphosphates, after suitable treatment, are being tried out as a substitute for bone meal. Internal parasitism is also a cause of heavy mortality and the use and benefits of phenothiazine and hexachlorethane are being demonstrated.

During the year large numbers of vaccinations were given against anthrax, blackquarter, blue tongue, contagious abortion, botulism, paratyphoid, horse sickness, fowl typhoid, distemper, rabies, fowl pox, and anaplasmosis, as well as 6,875 treatments with dimidium bromide; 180,285 small stock were dipped for scab.

The department has a big field of usefulness in remedying existing faults in native methods of animal husbandry, in controlling disease, and in encouraging the full and proper use of animal products. It is to be hoped that shortage of staff does not continue for long to hamper the progress of this important work.

W. W. H.

ABSTRACTS

Hypomagnesaemia in Milking Cows*

To investigate hypomagnesaemia of milking dairy cows during the few days following the change from stall feeding to spring grazing the authors used a pasture of 7·2 acres of a uniform clean sward sown under oats in 1951. The grass mixture per acre consisted of 7 lb. cocksfoot S.43, 7 lb. cocksfoot S.37, 3 lb. white clover S.100. After grazing the young sward in the autumn of 1951 the whole field was dressed on February 12th, 1952, with 2·5 cwt. superphosphate per acre. It was then divided by electric fence into:—

Plot A. 1·6 acres. Received 25 cwt. commercial calcined magnesite per acre, followed in two days and again on March 12th by 3 cwt. sulphate of ammonia.

Plot B. 3 acres. Received 3 cwt. sulphate ammonia per acre on the same dates as Plot A.

Plot C. 2·6 acres. Received 4 cwt. sulphate of potash per acre on February 22nd. This treatment rapidly produced a clover-dominant sward.

On February 24th, 1953, the whole pasture was dressed with 1·8 cwt. triple superphosphate per acre. Plot A now received 3 cwt. per acre sulphate of ammonia, repeated on March 14th. Plot B was divided into Plot B 1 (1·5 acres), which received the same treatment as Plot A, while Plot B 2, used as a control, had no further fertilising. Plot C received a further 4 cwt. sulphate of potash per acre as in the previous year. But by March 24th, it was found necessary to reduce the exuberant clover growth by spraying with Cornox-D.

In 1952 the serum-magnesium levels of the 22 Shorthorn, Friesian and Guernsey cows under observation were plotted at least twice per week. Three of the four cows on Plot A showed no hypomagnesaemia up to 20 days after going to grass; at this point these animals were transferred to Plot B, where, within a week, two of them showed a rapid fall in serum-magnesium. Four other cows receiving concentrates in addition to grazing on Plot B showed an irregular slow downward trend, whereas eight more, turned

* **Influence of Fertiliser Treatment of Grassland on the Incidence of Hypomagnesaemia in Milking Cows.** Bartlett, Brown, *et al.* (1954). *Brit. vet. J.* **110.** 3–19.

out directly on to this plot without concentrates, showed a very rapid fall to 0·5 mg. per 100 ml. serum, and four developed symptoms typical of grass tetany. Of the six cows on Plot C, four fell below the common normal range, but the minimum was 1·1 mg. per 100 ml. An upward trend in serum magnesium was noted on this plot later in 1952 and was thought to be due to the preponderance of clover in the sward.

The results obtained in 1953 confirmed those of the previous year. After five cows had been on Plot A for 18 to 25 days they were transferred to Plot B 1. In all cases a marked fall occurred in serum-magnesium within three days. Six of the seven turned directly on to Plot B 1 showed a rapid fall resulting in one case of clinical grass tetany and two sudden deaths. The remaining four were transferred to Plot A and this change resulted in a fairly rapid return to normal serum levels in six days. On the undressed Plot B 2 a slight fall was observed. Serum-magnesium levels of the four cows on Plot C were considerably lower in 1953 than in 1952, suggesting that the suppression of most of the clover had left a sward almost as capable of producing hypomagnesaemia as one heavily dressed with sulphate of ammonia.

The authors consider that the effects of disproportionate clover-grass balance in swards is worth further investigation.

J. A. P.

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Rickets in Sheep*

In December, 1951, in Ayrshire 20 ram hoggs reared on lowland pasture from four months were given 2,000,000 I.U. vitamin D_2 *per os*. Eighteen similar rams remained as controls, and the two groups grazed together on a 15-acre new ley.

Half the controls developed severe rickets and lost weight. Gains in the remainder were not equal to the best in the experimental group, although the controls showing greatest gain were latest in developing rickets, suggesting that an increase in weight is necessary before symptoms appear. Disability then prevents normal feeding with resultant weight loss.

Serum levels were Ca. 11·3 mg. per 100 ml. and P. above 5 mg. per 100 ml. in the dosed rams compared with Ca. 6·73 mg. per 100 ml., and P. below 4 mg. per 100 ml. in the undosed.

After a month, early symptoms of rickets appeared in five treated rams. A further dose of 2,000,000 I.U. vitamin D_2 to both groups led to all-round recovery. Two doses of vitamin D_2 during the winter are, therefore, required to prevent "bent leg" in young rams. This is in agreement with the recommendations of other workers.

C. M. E.

* **Rickets in Sheep.** Dunlop, G. (1954). (Correspondence.) *Nature*. **173**. 453.

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Control of Copper Storage in the Liver of Sheep*

The experiments were carried out in an attempt to resolve the dispute concerning the rôle of molybdenum in the metabolism of copper. It had been suggested that in Australia the absence of molybdenum in the diet of sheep resulted in a rapid accumulation of copper in the liver of sheep and an excess of molybdenum caused a copper deficiency. This hypothesis has not received general acceptance and has been rejected in Great Britain.

Experiments showed that when sheep on lucerne hay were given 10 mg. per day extra molybdenum, the copper storage in the liver was reduced over a three month period. In contrast when sheep were fed oat hay with the same molybdenum supplement there was no significant change in liver copper values.

In a second series of experiments potassium sulphate was added to the oat hay so that the sulphate intake was balanced for both types of hay. On both diets, lucerne hay and oat hay, molybdenum was now shown to reduce the liver-copper storage, the extra potassium being without significance. When the sulphate intake of sheep is about 2 g. per day, as little as 0·5 mg. molybdenum per day will significantly limit copper storage. It appears, therefore, that molybdenum in the diet has an action on the retention and storage of copper in the sheep provided the diet is rich in sulphate.

These results may explain the variations in results obtained by different workers. The sulphate content of plants is probably low in actively growing plants when protein synthesis is active, and at this time sheep would store copper even if the plant molybdenum content was relatively high. Copper deficiency could possibly develop when the sulphate content of plants rises later in the season.

F. R. B.

* **The Control of Copper Storage in the Liver of Sheep by Inorganic Sulphate and Molybdenum.** Dick, A. T. (1953). *Aust. vet. J.* **29**. No. 9.

VICTORIA VETERINARY BENEVOLENT FUND

A meeting of the Council of the Victoria Veterinary Benevolent Fund was held at No. 10, Red Lion Square, London, W.C.1, on April 7th, when the following members were present: Professor J. B. Buxton (President) in the chair, Professors R. E. Glover, J. McCunn, C. W. Ottaway, L. P. Pugh and Mr. Arnold Spicer. Mr. C. W. Francis, Secretary, was in attendance.

Minutes.—The minutes of the previous meeting held on February 4th, 1954, having been published were taken as read and signed as correct.

Apologies for Absence.—Apologies for absence were received from Messrs. H. Bell, H. W. Dawes, Major J. J. Dunlop, Mr. G. N. Gould, Mrs. D. I. Glover, Mr. L. E. Hughes, Professor P. E. Mullaney, Professor W. L. Weipers, Captain A. Whicher and Major W. H. Wortley.

Hunting Trust.—The Secretary reported that the Trustees had on March 4th, 1954, in accordance with the terms of the Trust, authorised the transference of the sum of £419 1s. to the General Account of the Fund, this being the surplus for the year as disclosed by the audited accounts.

Treasurer's Report.—In the absence of the Treasurer, the Secretary reported that the Treasurer had caused the Hunting Trust balance of £419 1s. mentioned in the previous minute, to be invested in the purchase of £490 3½ per cent. Conversion Stock, and his action was approved.

Accountant's Report.—The following report was read and approved, a cordial vote of thanks being accorded to the respective donors.

Since the previous meeting the following donations have been received:—

Collecting Boxes.

	£	s.	d.	£	s.	d.
Central Veterinary Society (two meetings)	3	4	6			
Eastern Counties Veterinary Society	3	8	6			
East Midland Division	2	5	6			
Scottish Metropolitan Division	2	1	7			
				11	0	1
Anonymous—" In memory of Mr. J. S. Blair, M.R.C.V.S." ...				1	0	0
Eastern Counties Veterinary Society				10	0	0
Eastern Midland Division—proceeds of Raffle at Annual Dance				17	11	0
Midland Counties Veterinary Association				25	0	0
National Greyhound Racing Club				10	0	0
Proceeds of Dance organised by Redditch District Members—per Mr. C. P. Renton				23	10	0
R.S.P.C.A., Southampton Branch				12	10	0
Whicher, Captain A.					10	6
Yorkshire Veterinary Society ...				5	5	0
				£116	6	7

Cases

No. 186.—Widow. Died on February 21st, 1954, aged 80. The Executive Committee reported that they had paid the doctor's fee of £2 2s., which was approved. It was also agreed to make a special grant of £10 towards the funeral expenses.

No. 239.—Widow. This recipient died on February 3rd, 1954, at the age of 79. A letter from the daughter, expressing her heartfelt thanks to the Fund for the help given to her mother, was read.

No. 274.—Widow, aged 81. Died on March 22nd, 1954. A letter from the daughter thanking the Council for the help given to her mother for many years and asking if the Fund could assist her with the funeral expenses was submitted.

It was resolved that the sum of £16 10s. be paid towards the funeral expenses in this case.

No. 273.—Widow, aged 45.

No. 281.—Widow, aged 51. Two children, ages 20 and 13.

A report on these cases having been received from a Special Committee of the Fund it was resolved that the grant to case No. 273 be discontinued as from May 1st, 1954, and that in the other case the assistance from the Fund be reduced from £2 to £1 per week as from May 1st, 1954.

It was further resolved that the thanks of the Council be conveyed to the Special Committee for its valuable assistance in these two cases.

Annual Report.—The draft of the Annual Report and Statement of Accounts was submitted and approved for issue to the Members of the Fund.

CHANGE OF ADDRESS

Readers in the West of England may wish to note that the Animal Health Division's office at Trowbridge has been moved to Homefield House, Polebarn Road, Trowbridge. (Tel.: Trowbridge 2258.)

IN PARLIAMENT

Slaughterhouses Bill, Second Reading

In introducing the second reading, the Minister of Food, Major Lloyd George, drew a broad picture of the situation that had to be faced. Before the war there were some 12,000 slaughterhouses in England and Wales, but following the concentration of the meat industry during the war the number of slaughterhouses had been reduced to about six hundred. The de-rationing of meat at the beginning of July would require that this number be increased, so far as he could forecast, to about 2,500. The Bill was an interim one in the sense that the present Government shared the opinion of its predecessor that over a period of time a long-term siting plan should be prepared, which would enable this country to have the best slaughtering system available. In the meantime, however, the problems raised by de-rationing must be solved. He commended the Bill to the House as the best temporary expedient that could be devised.

Mr. Robens was concerned with the problem of hygiene in the large number of slaughterhouses that would be licensed in the next few months. People were much more concerned, he said, about hygiene and cleanliness in relation to food than had been the case fifteen years ago. He did not believe that the local authorities had enough inspectors to do this work adequately. It would mean asking existing inspectors to multiply, up to five times, the amount of work they did now. He could not see how this was to be achieved but he urged the Government to make certain that there is no diminution in the standard of inspection. Mr. Willey emphasised the hygienic aspect of the matter also. He said the slaughterhouses of this country were a national disgrace, and that high priority should be given to their improvement.

Mr. David Pryde introduced the topic of the hygienic transport of meat of which, he said, there was no mention in the Bill. He had seen in his own constituency lorry loads of meat, inadequately covered, standing in a narrow street. It was not necessary to emphasise the danger to public health. The Minister should take cognisance of these matters.

Sir Robert Boothby contrasted methods of slaughter and inspection in Scotland with those in England, considerably to the disadvantage of the latter. The methods of slaughter in England had never been very satisfactory, he said, and many of the 600 slaughterhouses working at the present time were below standard. They did not provide cold-storage facilities or facilities for dealing with by-products on the spot. Both these things he believed to be essential.

The Bill was read a second time and committed to a Standing Committee.

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Questions

Attested Stock (Movement Licensing)

Colonel Stoddart-Scott asked the Minister of Agriculture the reasons for maintaining a system of movement licensing for farm stock; and when he intends to terminate this control.

Sir T. Dugdale: I understand that my hon. and gallant Friend is referring to control of movement of attested stock to shows and sales. I consider that such control is necessary and I am explaining the reasons fully by letter.

Colonel Stoddart-Scott: Would my right hon Friend agree that now that the majority of our herds are becoming attested, the burden of getting a movement licence should fall more upon the owners of the non-attested than of the attested herds?

Mr. T. Williams: Is the right hon. Gentleman aware that the nearer we are getting to complete attestation the greater the measure of control which must be exercised?

Sir T. Dugdale: I think that on this occasion I can agree with both my hon. and gallant Friend and with the right hon. Gentleman. The position is that no permit is required to-day under the scheme for the movement of an animal from an attested herd to one which is not subject to the rules of the scheme, or to the non-attested section of a show or sale, but in that case the animal cannot afterwards return to the attested herd.

PROGENY TESTING SCHEME

Lieut.-Colonel LIPTON asked the Minister of Agriculture what arrangements have been made to extend the progeny testing scheme in order to produce better bacon at lower cost.

Sir T. DUGDALE: I am not yet able to add to the reply I gave to the hon. Member for Gloucestershire, West (Mr. Philips Price) on February 25th and to paragraph 26 of the 1954 Annual Review White Paper.

Lieut.-Colonel LIPTON: Will the right hon. Gentleman press for the earliest and widest possible extension of progeny testing in view of the colossal waste involved in producing 13 different breeds of pigs? Denmark has only one. No one knows what the average conversion factor in this country is. We are completely in the dark, and considerably handicapped compared with Danish producers.

Sir T. DUGDALE: This problem, with others, is under urgent consideration, and I assure the House that we are getting on with it as quickly as possible.

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PROTECTION OF SWANS

Mr. AWBERY asked the Secretary of State for the Home Department if he will take steps to include swans on the list of protected birds in order to preserve them, their cygnets and eggs, from unnecessary pain and destruction.

Sir D. MAXWELL FYFE: Wild swans are at present fully protected in 25 counties in England and Wales, and their eggs in 29 counties, by local orders made under the Wild Birds Protection Acts. I have no power to make additional orders except on application by the local authority. The Protection of Birds Bill now before Parliament will give full protection to wild swans throughout the country.

Mr. AWBERY: Could the Home Secretary give power to local authorities not only to protect the birds from destruction, but to provide them with food and shelter at the ponds and lakes where they congregate?

Sir D. MAXWELL FYFE: I should like to have a look at that aspect of the problem.

NOTES AND NEWS

Diary of Events

May 12th.—Meeting of the Editorial Committee, B.V.A., at 7, Mansfield Street, W.1, 11 a.m.

May 12th.—Meeting of the R.A.V.C. Division, B.V.A., at the Canine Research Station, Newmarket, 11 a.m.

May 12th.—Annual General Meeting of the National Veterinary Benevolent and Mutual Defence Society at the Midland Hotel, Manchester, 2.30 p.m.

May 13th.—Annual General Meeting of the Essex Division, B.V.A., at the Essex Institute of Agriculture, Writtle, 7.30 p.m.

May 15th.—Annual Sports Day of the Royal Veterinary College Athletic Club at Goring Recreation Ground, 2 p.m.

May 19th.—Meeting of the Royal Society of Medicine, Section of Comparative Medicine, at the Society's House, 1, Wimpole Street, W.1, at 5 p.m.

May 19th.—Spring Meeting of the Eastern Counties Division, B.V.A., at the Bedford Lodge Hotel, Newmarket, 11.45 a.m.

May 20th.—Ordinary General Meeting of the South-Eastern Division, B.V.A., at the Royal Star Hotel, Maidstone, 2.30 p.m.

May 20th.—Meeting of the Sub-committee revising the B.V.A. Calf Report at 7, Mansfield Street, W.1, 11 a.m.

May 26th.—Meeting of the Southern Counties Division, B.V.A., at the Polygon Hotel, Southampton, 6.30 p.m.

May 26th.—Annual General Meeting of the Society of Women Veterinary Surgeons. (See notice for details.)

May 27th.—General Meeting of the Herts and Beds Division, B.V.A., at the George Hotel, Luton, 7.30 p.m.

May 27th.—Meeting of the Sub-committee *re* Nutrition Conference at 7, Mansfield Street, W.1, 11 a.m.

May 27th.—Meeting of the Technical Development Committee at 7, Mansfield Street, W.1, 2.15 p.m.

June 1st.—One hundred and eleventh Annual General Meeting of the Royal College of Veterinary Surgeons at 10, Red Lion Square, London, W.C.1, at 12 noon.

June 1st.—Annual General Meeting of Victoria Veterinary Benevolent Fund at Royal College of Veterinary Surgeons, 10, Red Lion Square, W.C.1, to follow the above meeting.

June 9th.—Meeting of the Scottish Metropolitan Division, B.V.A., at the Minden Hotel, Peebles, 2.30 p.m.

June 11th.—Annual Dinner of the R.A.V.C. Officers Club at the Grosvenor House, Park Lane, London, W.1.

Sept. 19th—25th.—72nd Annual General Meeting and Congress of the British Veterinary Association at Torquay.

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R.C.V.S. EXAMINATIONS

Monday, May 10th.—Pharmacology, etc., Examination (Revised Syllabus) Oral and Practicals (London and Dublin).

Tuesday, May 11th.—Animal Management Examination commences at Edinburgh.

Thursday, May 13th.—Entries for D.V.S.M. Examination due.

Thursday, June 10th.—D.V.S.M. Written Examinations commence at Edinburgh.

Monday, June 14th.—D.V.S.M. Orals and Practicals commence.

Thursday, June 24th.—M.R.C.V.S. Written Examinations.

Friday, June 25th.—Ditto.

Monday, June 28th.—M.R.C.V.S. Practical and Orals commence (Panels "A" and "B").

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PERSONAL

Birth.—MONKS.—On April 22nd, 1951, at Bungay, Suffolk, to Jean, wife of Richard Monks, M.R.C.V.S., a son—Paul.

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Appointments.—Mr. I. N. Ritchie, Chief Veterinary Officer of the Ministry of Agriculture and Fisheries, has been appointed to the Agricultural Research Council.

Lieutenant D. R. Lane, B.SC., M.R.C.V.S., R.A.V.C., has been posted to No. 2 Dog Coy., Cyrenaica. He was stationed at the R.A.V.C. Training Centre, Melton Mowbray, Leicestershire.

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MEAT INSPECTION DELEGATION

The delegation, consisting of two Members of Parliament—Mr. A. J. Champion, M.P., and Mr. Robert Crouch, M.P.—and two members of the profession—Mr. Horace Thornton and Dr. W. R. Wooldridge—which made a short tour of the Continent to inspect abattoirs, returned last week. The tour was of more than 4,500 miles, and included the cities of Rotterdam, Hamburg, Paris, Madrid and Copenhagen. A report will be available within a few weeks, but on arriving back in England the delegation stated: "After our tour of more than 4,500 miles, we have been tremendously impressed by the care lavished on meat inspection by the veterinary services in these countries, whose problems are similar to our own. The standards are high, and technical advances are considerable. There is a lesson for Britain here."

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REINDEER IN SCOTLAND

The recently published report, Agriculture in Scotland, gives an account of the Reindeer Council's experiment designed to ascertain whether these animals can be reared successfully in Scotland. There has been a high death-rate, as, out of a total of 18 reindeer imported, only six now remain. The animals were carefully tended both by their herdsmen and by veterinary surgeons and on the death of each animal a *post-mortem* was carried out. As a result of these observations, it was decided that the first reserve was too boggy and low-lying.

Attacks by flies and parasites seem to have been the original cause of most of the deaths. It has now been decided to continue the experiment on a new reserve, which includes the northern slopes of Cairn Gorm and additional reindeer are to be introduced from Sweden. The six animals who have survived from the original experiment are in good health and show no sign of disease.

SMALL-ANIMAL PROBLEMS

Members will probably have seen in the Supplement to the March 20th issue of *The Veterinary Record* that the Technical Development Committee has been enlarged by the alteration of a by-law on a special resolution of the Council. Six extra members with a particular interest in small-animal problems have been appointed, and at a special meeting of the whole Committee it was decided to make a survey of the incidence and distribution of disease in small animals throughout the country.

The Committee would be glad if members would help in this work by notifying *the General Secretary, B.V.A., 7, Mansfield Street, Portland Place, London,* of the SIX most important diseases or conditions seen in their own practices—in order of importance if possible—indicating whether the importance is due to the number of animals affected or to the high rate of mortality.

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MAJOR HAMILTON KIRK AT THE WHITE CITY

His many friends will be interested to learn that Major Hamilton Kirk, who was for many years connected with veterinary services at greyhound racing tracks, has taken up this branch of work again. He is acting as veterinary surgeon at the Greyhound Racing Association's tracks at White City, Harringay and Stamford Bridge. He was veterinary surgeon at Clapton when the track was first opened and remained for 20 years, until he transferred to Wandsworth. Some years afterwards he returned to full-time private practice. It will be remembered that Major Hamilton Kirk has propounded the possibility that infantile paralysis might be connected with canine virus diseases. In this connection readers will recall a recent note in the *Record* to the effect that a veterinary surgeon may be appointed in Bristol to advise the Medical Officer of Health on the relationship of animal health to that of the general public.

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HYGIENIC TRANSPORT OF MEAT

An Edinburgh firm has designed a special hygienic truck for the transport of meat. Its features include a non-corrosive metal or plastic body, with the carcases slung from hooks on an endless steel track to allow easy loading and unloading. The whole of the interior is rounded or curved to allow for easy and complete cleaning, and the truck is completely closed so as to exclude dust, flies, etc. One of these trucks has been operating successfully in Fife for some time past, and enquiries for others have come from all parts of Britain.

The work of Mr. John Norval, Chief Veterinary Inspector of Edinburgh, who has constantly emphasised the importance of greater hygiene in the transport of meat, has been largely responsible for stimulating a degree of interest in the subject that made the production and the use of this specially designed vehicle possible.

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HOSPITALITY REQUIRED

Would any member be good enough to receive in his home during the month of July the 17-year-old son of a French veterinary surgeon living at Affreville, Algeria? The boy has been learning English for five years at school and wishes to practise the language in England in preparation for his school leaving examination next year. His father wishes to pay all expenses, as he feels he cannot offer return hospitality to an English boy or girl because of the climate of Algeria.

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An Austrian woman student of the Veterinary College, University of Vienna, has written asking if she could see practice both in England and Scotland during the summer vacation this year, between July 15th and September 15th. In return for hospitality would be willing to help in any way she could.

Members who may be interested in either of these suggestions are asked to write to the General Secretary, B.V.A., 7, Mansfield Street, London, W.1.

ADDRESSES OF DISEASE-INFECTED PREMISES

The list given below indicates, first, the county in which are situated the premises on which disease has been confirmed, followed by the postal address and date of outbreak.

ANTHRAX:

Denbighs.—Nantclwyd Hall, Ruthin (Apr. 29); Ty Brith, Nantclwyd, Ruthin (Apr. 30).

Kirkcudbright.—Ingleston Farm, Twynholm, Castle Douglas (Apr. 28).

Northampton.—85, Irthlingborough Road, Wellingborough; Doddington Road, Wellingborough (Apr. 29).

Northants.—Victoria Field, Chester Farm, Ichester (Apr. 30).

FOOT-AND-MOUTH DISEASE:

Berks.—Old Mill Farm, Aldermaston, Reading (Apr. 27).

FOWL PEST:

Essex.—Hazeldene, Hovefields Avenue, Basildon, Billericay (Apr. 27).

Lancs.—Staley Dene, Station Road, Little Hoole; Ravenskerne Poultry Farm, Pine Avenue, and Moorhey Farm, Little Hoole; Frog Hall, Inskip; Bridge Farm, St. Michaels-on-Wyre; Manor Farm, Croston, Preston (Apr. 27); Primrose Cottage, Station Road, Little Hoole (field opposite); The Bungalow, Little Hoole (May 2).

Surrey.—Sandycroft, Mill Lane, Felbridge, East Grinstead (Apr. 29).

Sussex.—Carylls Nursing Home, Faygate, Horsham (Apr. 29).

SWINE FEVER:

Berks.—110, Church Road, Tilehurst, Reading (Apr. 28).

Bucks.—Murtlands Farm, North Crawley (Apr. 28).

Cambs.—May Street, Steeple Morden, Royston (Apr. 30).

Ches.—Lowcross Farm, Tilston, Malpas; Cotton Hall, Cotton Edmunds, Chester (Apr. 28); Colshaw Hall Farm, Dean Low Road, Wilmslow; Larkton Hall, Larkton, Malpas; Outwood Farm, Cheadle (Apr. 30); Arrow House Farm, Upton, Birkenhead (May 1).

Derbys.—Higher Fold Farm, Rowarth (Apr. 27); Poplar Farm, Rowarth, Stockport (Apr. 29).

Gloucs.—Gamage Court, Ley Lane, Minsterworth (Apr. 29).

Lancs.—Fishpond Farm, Stoney Lane, Rainhill, Liverpool (Apr. 27); 18, Smallholding, Highfield Estate, Levenshulme, Manchester (Apr. 29); No. 6 Smallholding, Highfield Estate, Levenshulme (Apr. 30).

Leics.—22, Northfield Road, Blaby, Leicester (Apr. 30).

Lincs.—"Four Winds," North Moor Road, Messingham, Scunthorpe (Apr. 29).

Rutland.—Bridge Pit Farm, Ketton, Stamford (Apr. 27).

Salop.—Sandome Gardens, Uffington, Shrewsbury (Apr. 28); Park Road Farm, High Ercall, Wellington (Apr. 29); Hirton Farm, Lea Cross, Pontesbury, Shrewsbury (Apr. 30); Brand Farm, Stirchley, Wellington (May 1).

Somerset.—Marston Road Farm, Frome (Apr. 30).

Staffs.—Salters Wells, Bagnall, Stoke-on-Trent (Apr. 29); Heath House Farm, Ipstones, Stoke-on-Trent (Apr. 30).

Suffolk.—Braiseworth Hall, Tannington, Woodbridge (Apr. 27).

Surrey.—Queens Hospital, Queens Road, Croydon (Apr. 27).

Sussex.—Oldfield Farm, Storrington, Pulborough (Apr. 27).

Yorks.—13, Stansfield Row, Leeds, 4 (Apr. 27); White Rose Mill, Laxton, Tadcaster; 10, Stansfield Row, Leeds, 4 (Apr. 29); 19, Chapel Street, Birdwell, Barnsley (May 1).